is a preferable condition on the points that excellent film quality can be obtained, an oxidation rate is high, a difference in oxidation rate depending on a pattern density becomes small, and the like.

Disclosure of the Invention

[0008] The present invention provides a method for manufacturing a semiconductor device capable of performing a selective oxidation treatment of a layer of polysilicon or the like at a higher temperature without oxidizing a tungsten or tungsten silicide layer, and a plasma oxidation method

[0009] One aspect of the present invention is a method for manufacturing a prescribed semiconductor device by forming a film mainly formed of tungsten and a film of a component different from the film mainly formed of the tungsten on a semiconductor substrate, comprising forming a first layer, which is formed of the film of the component different from the film mainly formed of the tungsten, on the semiconductor substrate; forming a second layer, which is formed of the film mainly formed of the tungsten, on the semiconductor substrate; and forming an oxide film on an exposed surface of the first layer by plasma processing **at a process temperature of 300°C or more** using a process gas containing oxygen gas and hydrogen gas at a [~~process temperature of 300°C or more~~] **flow rate ratio (hydrogen gas flow rate/oxygen gas flow rate) of the hydrogen gas to the oxygen gas of 2 or more and 4 or less**.

[0010] Another embodiment of the present invention is a method for plasma oxidation of a film of a component different from a

film mainly formed of tungsten of a semiconductor substrate on which the film mainly formed of the tungsten and the film of the component different from the film mainly formed of the tungsten are formed, comprising forming an oxide film on an exposed surface of the film of the component different from the film mainly formed of the tungsten by plasma processing **at a process temperature of 300°C or more** using a process gas containing oxygen gas and hydrogen gas at a [~~**process temperature of 300°C or more**~~] **flow rate ratio (hydrogen gas flow rate/oxygen gas flow rate) of the hydrogen gas to the oxygen gas of 2 or more and 4 or less**.

[0011] The present invention can be applied to the forming of a gate electrode of a transistor, and performs plasma oxidation of side surfaces of the gate electrode.

Brief Description of the Drawings

[0012] Fig. 1 is a schematic view (sectional view) showing an example of the structure of a plasma processing apparatus according to the present invention.

[0013] Fig. 2A and Fig. 2B are diagrams schematically showing states that an oxide film is selectively formed on a gate electrode according to the present invention, Fig. 2A shows a state before plasma oxidation, and Fig. 2B shows a state after the plasma oxidation.

[0014] Fig. 3A and Fig 3B are diagrams schematically showing states of a gate electrode having an oxide film formed on side surfaces of a laminated gate electrode, Fig. 3A shows a gate electrode undergone plasma oxidation, and Fig. 3B shows a gate electrode undergone oxidation at a high temperature illustrated

for comparison.

[0015] Fig. 4A and Fig. 4B are graphs showing a change in oxidation of a tungsten layer by plasma oxidation, Fig. 4A